Materials Research for Advanced Data Storage

Industrial Outreach

At the University of Alabama

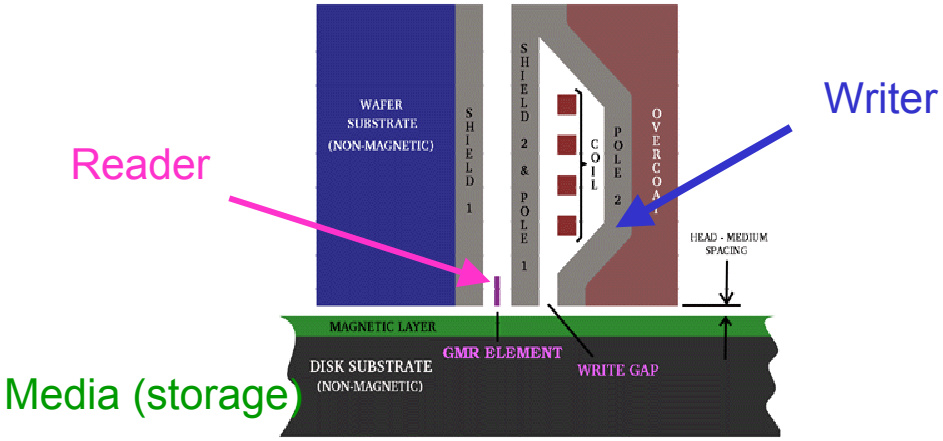
Center for Materials for Information Technology

An NSF Materials Research Science and Engineering Center

Magnetic Recording Requires Writing, Storing and Reading

MINT is making Critical Contributions In Each Area

- Writng
  - Magnetically soft, high moment FeCo developed for writer.
- Storing (Media)
  - Self-Assembling Arrays of High-Anisotropy Magnetic Nanoparticles to Defeat Superparamagnetic Limit
  - Soft, Low Noise Underlayers for perpendicular Recording Media
- Reading
  - Confined Current Path Current Perpendicular to the Plane GMR for high sensitivity reader

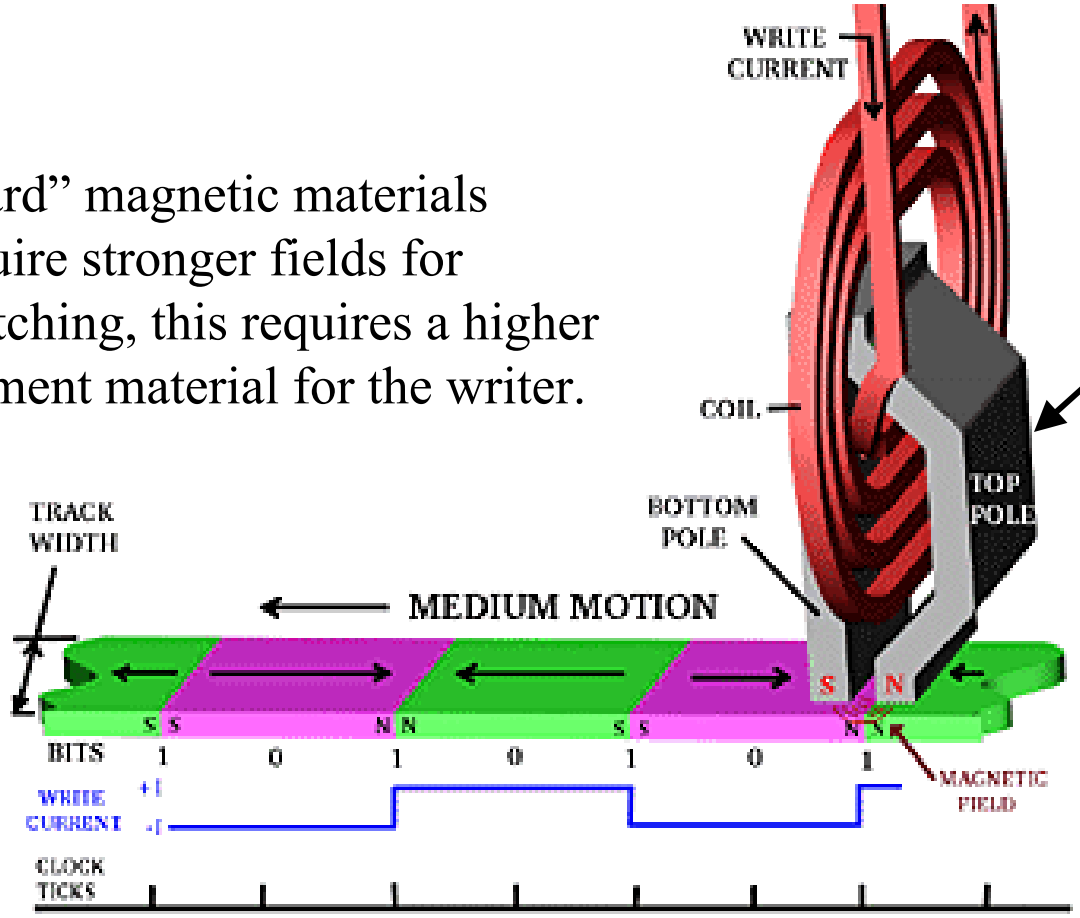


Integrated Read and Write Head (From ReadRite web site)

Here we concentrate on two recent success stories.

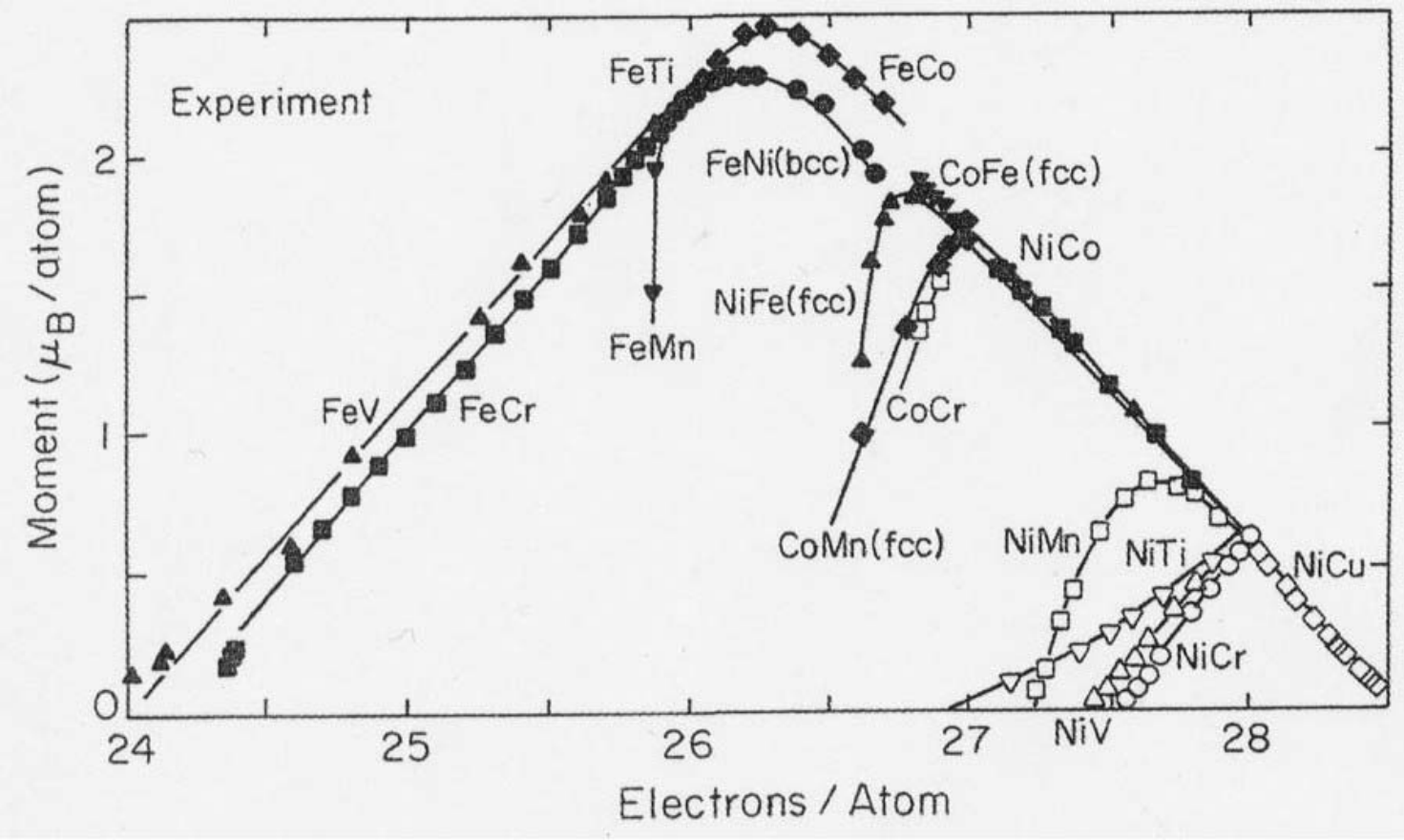
Writing – Soft, High-Moment Ferromagnetic Material is Critical

"Hard" magnetic materials require stronger fields for switching, this requires a higher moment material for the writer.



(From ReadRite web site)

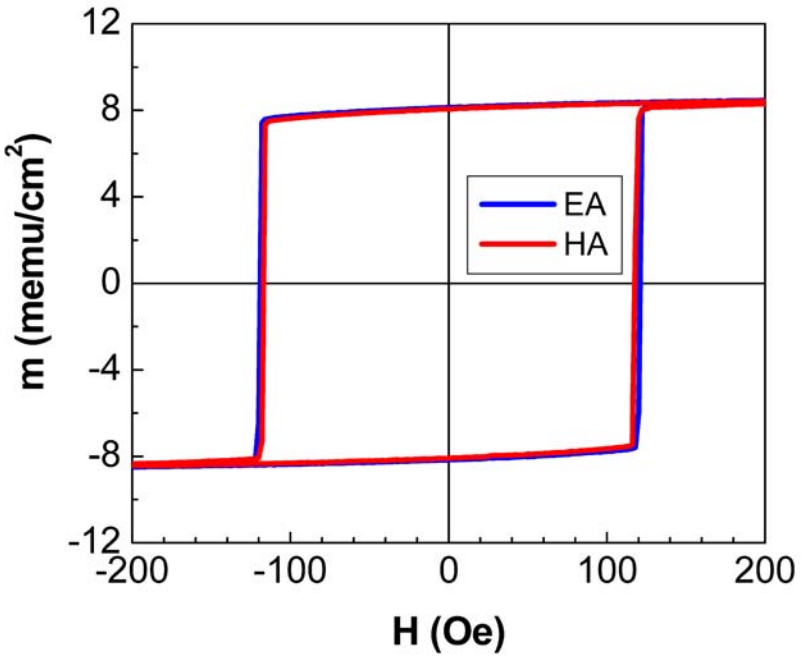
Slater-Pauling Curve



FeCo has highest known Magnetization

Comparison of Hard and Soft FeCo Films

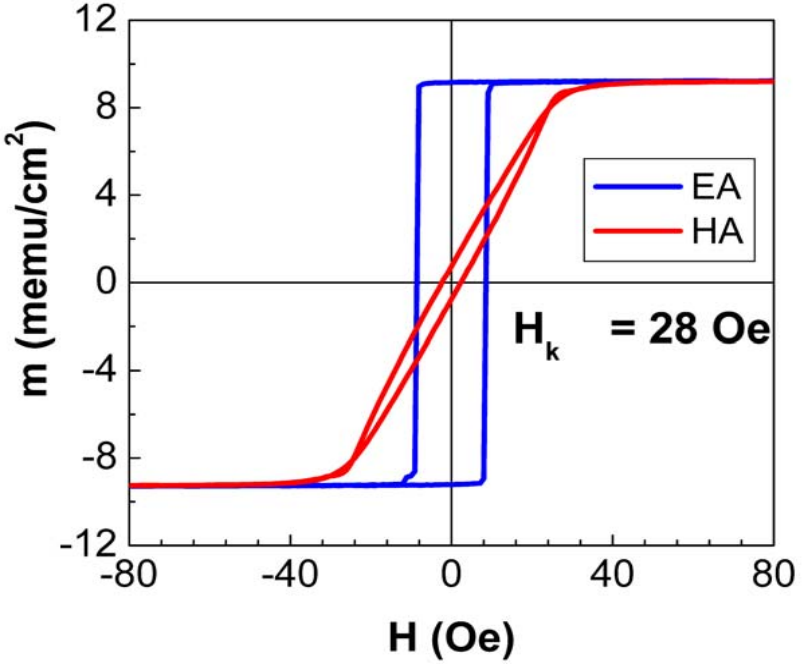
G/FeCo (50 nm)



$H_{c,\,EA} = 120$ Oe

$H_{c,\,HA} = 117$ Oe

G/Cu(2.5 nm)/FeCo (50 nm)



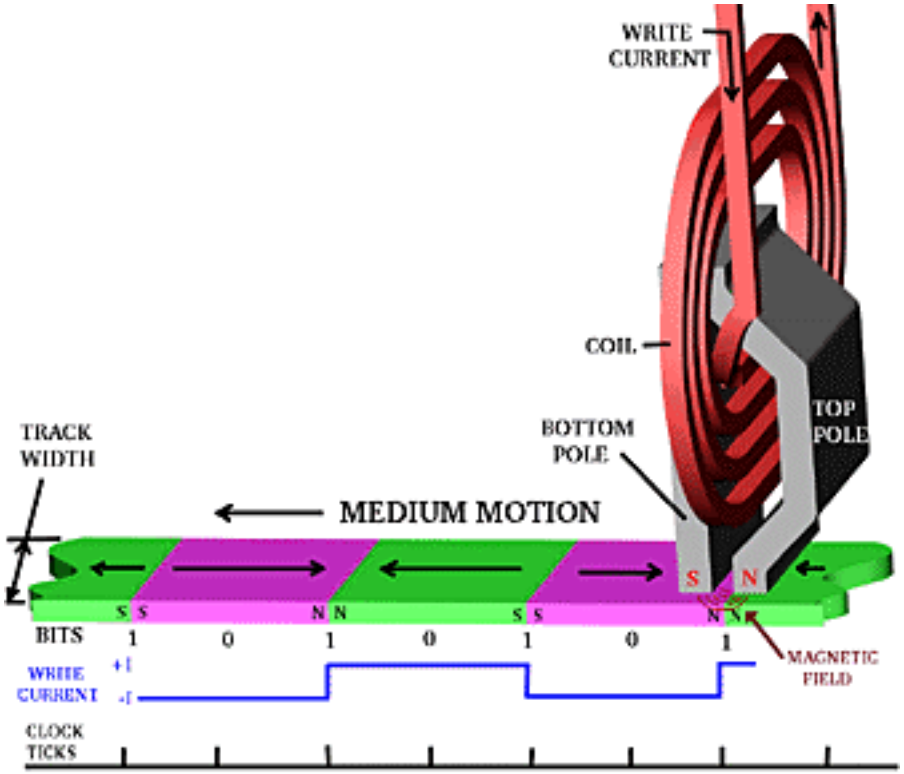
$H_{c,EA} = 8.6$ Oe

$H_{c,HA} = 2.3$ Oe

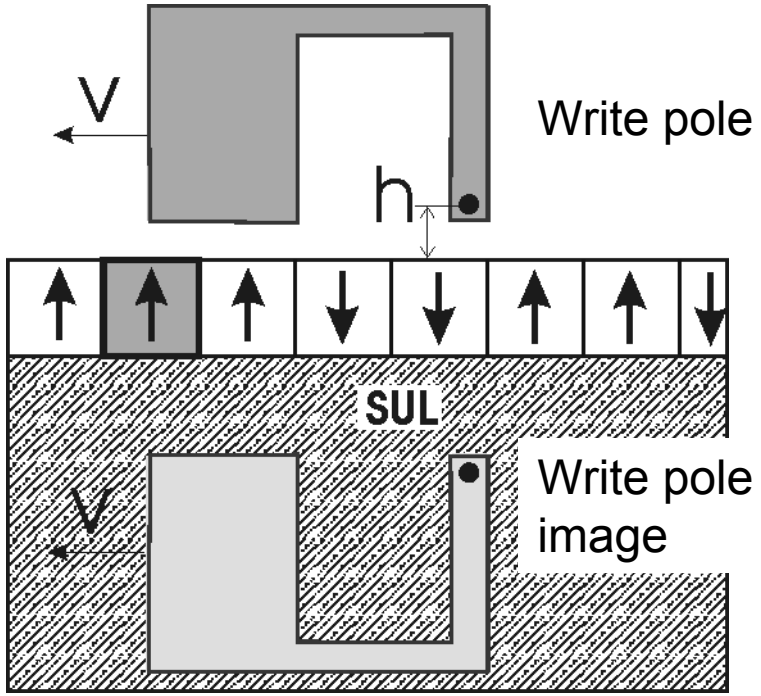
- Accomplishment
  - FeCo, the material with the highest known saturation magnetization was made magnetically soft by careful design and control of an extremely thin underlayer film.
- Significance
  - Soft FeCo can now be used in the writer. This will provide stronger fields on the media and will allow industry to use higher coercivity media that has greater thermal stability.
- Implications for Industry
  - It is expected that FeCo will be used in next generation write heads.

Perpendicular vs. Longitudinal Recording

Importance of Soft-Underlayer (SUL)



Longitudinal

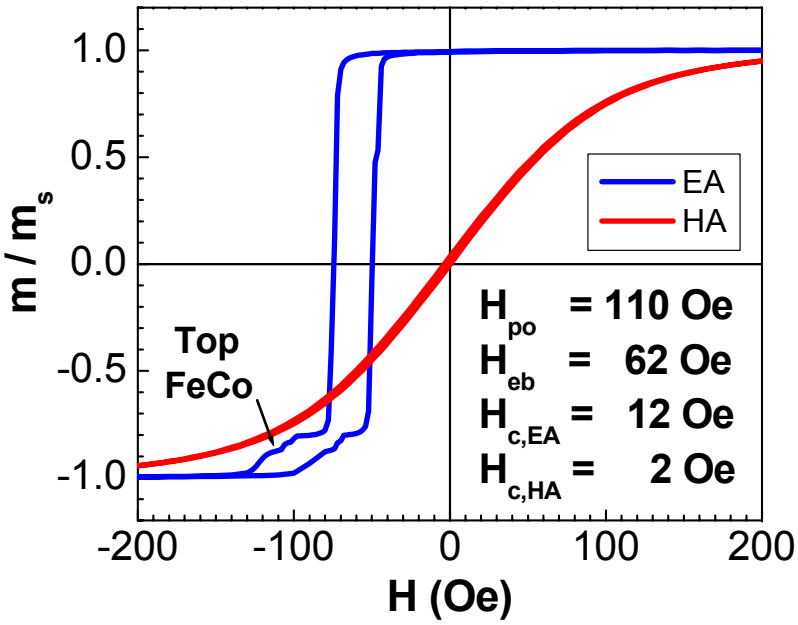


Perpendicular

High Moment $Fe_{65}Co_{35}$/IrMn Soft Underlayers

G/Cu(20 nm)/IrMn(10 nm)/[FeCo (50 nm)/IrMn(10 nm)]$_4$/FeCo (25 nm)

- Solution to problem of noisy soft underlayer
  - Make entire underlayer a single domain
  - Use exchange bias effect to shift the hysteresis loop so that there is only one state for H=0.
  - Set easy axis so that the SUL responds in linear noise-free fashion.



- Accomplishment
  - Soft underlayer for perpendicular recording was designed using the principles of exchange bias so that the underlayer for the entire disk is a single domain.

- Significance
  - This eliminates the noise associated with domains switching which had prevented perpendicular recording being used for data storage.

- Implications for Industry
  - It is expected that perpendicular recording will now be possible through the use of this soft underlayer. Perpependicular recording is expected to allow higher density without thermal instability because higher coercivity media can be used.